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सार्वजनिक संबोधन तंत्रों के आंतरिक संस्थापन — रीति संहिता

(पहला पुनरीक्षण)

Indian Standard

CODE OF PRACTICE FOR INDOOR INSTALLATION OF PUBLIC ADDRESS SYSTEMS

(First Revision)

ICS 91.140.01

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

September 1998

Price Group 5

Acoustics Sectional Committee, LTD 5

FOREWORD

This Indian Standard (First Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Acoustics Sectional Committee had been approved by the Electronics and Telecommunication Division Council.

This Indian Standard was first issued in 1961. The revision has been taken up to bring it in line with the latest developments in the field of public address systems.

The installation and use of amplifying systems for public and private functions have been greatly on the increase in the past few years. While in some instances such installations are done by professional engineers, more often than not, installation by non-professional people show inadequate attention to essential details and under such circumstances, even the best pieces of Public Address equipment do not give their optimum performance. This code has been prepared with a view to act as a guide for indoor installations (permanent as well as temporary) taking into consideration the practical limitations and requirements which are normally met with.

The installation of sound distribution system in closed auditoria and other enclosures calls for careful choice of equipment, positioning of the various units of the system and many other precautions to be taken in order to obtain the optimum performance from such a system. As is well known, the acoustics of the hall or enclosure itself plays a significant role in the ultimate effect of the installation. These aspects are taken into consideration while preparing this code. However, it is also recommended that for large scale installations, advice of a competent and qualified sound engineer should be sought. Such an engineer should be able to assist in preparing an initial statement of the exact requirements of the equipment to meet a particular situation and later on confirm that the installation offered is likely to meet the needs of such a situation.

This code covers the preliminary steps to be taken, design consideration, choice of equipment and installation practices including installations of column loudspeakers. Since most of the public address installations work from electric mains supply, the need for safety precautions is obvious. Consideration has, therefore, been given in this code to the best practices of earthing and other steps to prevent electrical shocks from accidental contact. Besides, a nomogram for easy determination of audio power required in the specified enclosure has also been included.

Unless specified otherwise, the requirements or characteristics of amplifier, specified in this standard are based on the methods of measurements specified in IS 9302 (Part 2):1979 'Characteristics and methods of measurements for sound system equipment: Part 2 Amplifiers'.

Installation of outdoor public address systems, though having many features in common with indoor systems, varies from the latter mainly on the question of effect of the acoustics of the hall or enclosure itself, and to cover it, a separate code of practice, namely, IS 1882 : 1961 'Code of practice for outdoor installation of public address systems', has been prepared.

Wherever a reference to any Indian Standard appears in this code, it shall be taken as a reference to the latest version of the standard.

All quantities and dimensions appearing in this standard have been given in metric system.

This code is intended chiefly to recommend the requirements of design and quality of equipment and the methods of installation of indoor public address amplifying and sound distribution systems, and it does not include all the necessary provisions of a contract.

In reporting the results of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised*)'.

Indian Standard

CODE OF PRACTICE FOR INDOOR INSTALLATION OF PUBLIC ADDRESS SYSTEMS

(First Revision)

1 SCOPE

This code of practice, dealing with the installation of public address systems inside closed auditoria and other similar enclosures, seeks to establish:

a) a standard practice for such installations, and

b) a proper set of criteria for good and reliable performance ensuring desired quality of reproduction from the system as a whole in the enslosure.

This code applies to temporary as well as permanent indoor installations.

2 REFERENCE

The following Indian Standard is a necessary adjunct to this standard:

IS No.	*Title*
616 : 1986	Safety requirements for mains operated electronic and related apparatus for household and similar general use

3 TERMINOLOGY

3.0 For the purpose of this code, the following explanation of terms shall apply.

3.1 Matching

One part of a circuit is said to be matched to another part when they are so designed as to give satisfactory operation when connected together. It does not necessarily imply maximum power transfer between units.

3.2 Controls

3.2.1 *Manually-Operated Controls*

These are operated manually for varying some performance characteristic of the equipment such as volume or tone. These controls may require adjustment during normal functioning of the installation.

3.2.2 *Preset Controls*

These are devices which vary some characteristic such as volume, tone or negative feedback of the equipment. Such controls are preset while setting up the equipment and testing the installation. These are normally inaccessible and are not required to be used during the operation.

3.3 Shielded Wiring

Wiring in which the conductor or conductors and their insulation are enclosed in an earthed and continuously low resistance conducting sheath, for example, metal sheathed cable or metal braided cable.

3.4 Stand-by Equipment

Equipment which is wired and kept ready for immediate substitution in case the main equipment fails in operation. Special switching circuits are used for such substitution.

3.5 Monitoring Equipment

Equipment such as output level indicator, loudspeaker or headphone connected to the output line of any stage of the public address system and used by the operator to assess the level and quality of the outgoing signal.

3.6 Amplifying System

That part of the installation which comprises of pre-amplifiers, mixers, equalizers and power amplifier.

3.7 Pre-Amplifier

The part of the amplifying system, essentially a voltage amplifier, suitable for operation with input source such as from microphone, tape player, etc. The output from such an amplifier is connected to a mixer or another amplifier operating at a higher input level.

3.8 Mixer

A mixer is a device used to mix two or more input signals from microphones as well as from input sources like cassette tape players, electronic organ, etc. The mixer also has inbuilt pre-amplifier so that mixer can be connected to another amplifer operating at higher input level.

3.9 Equalizer

An equalizer is a circuit to perform equalization which is a technique employed in transmitting, recording or amplifying program material by which selected frequencies are compensated in order to obtain a desired overall frequency response. The term is also applied to the matching of sound systems to room acoustics by the use of filter.

3.10 Power Amplifier

The part of the amplifying system intended to amplify the signal derived from pre-amplifier, mixer and equalizer to a level capable of driving load, that is, loudspeaker.

3.11 Patch Cord

A short piece of shielded cable for connecting the input and output circuits of the various items of equipment in the system, terminated at either end in suitable plug corresponding to the type of jacks used in the system.

3.12 Column Loudspeaker

A group of loudspeakers (connected in phase) of either direct radiator or compressor driver horn type mounted close to each other on a suitable fixture in linear fashion to form a column.

3.13 Loudspeaker Cluster

A combination of direct radiator type LF driver and HF driver (direct radiator or compression type) with frequency divider network. These are generally used for high quality installation.

4 PRELIMINARY STEPS

4.1 Exchange of Information

The initial and ultimate requirements of the installation should be ascertained as accurately as possible by prior consultation between the parties concerned. On the basis of this information, plans should be prepared showing:

a) details of the installation proposed,

b) the accommodation and location of central amplifier equipment, and

c) the ducts and overhead lines that may be required for wiring.

4.2 Approval of Plans

Approval of plans for the proposed installation should be obtained from the authority concerned well in advance.

4.3 Power Supply (*see also* 8.6)

Local electricity authorities should be contacted for providing the electric power supply mains near the proposed location of the central equipment. The installation should be normally operated from 240 volts, single phase, 50 Hz AC mains supply and preferably capable of operation from 12-14 V storage battery.

4.4 Accommodation

The location of the central equipment, loudspeakers, microphones, etc, should be agreed between engineers and the authorities concerned and the accommodation reserved at an early stage.

4.5 Ducts and Cables

A cabling plan should be drawn up and agreed to in accordance with requirements both from the convenience and technical point of view. In case of lines which have to run outside the property con cerned, the right of way should be obtained from the Posts and Telegraphs Department or these should be got laid by that Department. In any case, an agreement for projection of the lines should be reached with appropriate authority such as Electricity Department, Posts and Telegraphs, Railways, etc, whenever necessary.

4.6 Circuit Plans and Operating Instructions

Complete block and schematic diagrams for the equipment installed should be prepared and made available along with the circuit diagrams for each of the equipment, at the place where the central equipment is located. The layout and sizes of the wiring and cabling should also be indicated. The loudspeaker load connected to each output line and the particulars of the line transformers should be indicated. The operating instructions should also be made available which, among others, should also indicate the rating of the fuses.

4.7 Time schedule for work (particularly in case of temporary installations).

4.7.1 *Ordering and Collecting of Central Equipment*

For temporary installations, the equipment should be ordered for or obtained at any early date to ensure availability at the time of installation.

4.7.2 *Installation of Central Amplifying Equipment*

Work may commence on the installation of the central equipment as soon as accommodation and mains power supply are made available.

4.7.3 *Installation of Loudspeakers, Microphones and Wiring*

These items should be installed at appropriate time after other arrangements like decoration, seating, etc, are completed. This will minimize the risk of damage or loss. Necessary supports and structures for the loudspeakers may be erected after the information mentioned in **4.1** has been obtained.

The wiring for the loudspeakers and microphones may be laid just sufficiently in advance of the appropriate time for completing the installation so that preliminary tests that may be necessary to decide on the type and position of loudspeaker could be made after an acoustic survey.

4.7.4 After completing the entire installation (including the stand-by equipment) it shall be pre-tested for at least 30 minutes for each and every section of the system. The complete system should also be pre-tested for 2 hours on dummy load.

NOTE — This condition is considered necessary to ensure safe and reliable operation free from faults and damages due to over heating and other possible defects that might develop in the initial period.

5 QUALITY OF MATERIAL AND COMPONENTS

5.1 Conformity to Specifications

All materials, equipment and other components of the installation should conform to the relevant Indian Standard specifications wherever they are applicable.

5.2 Socket Outlets and Plugs

The socket outlets and plugs used for the installation should not be interchangeable with those used for electric lights or other power circuits.

6 DESIGN CONSIDERATIONS

6.1 General

Output from the microphone, record player, compact disc player, tape recorder, radio tuner or the reproduction from sound film, is amplified and presented to the audience in the enclosure at the requisite volume level through loudspeakers installed at chosen locations inside the enclosure. For obtaining optimum performance from such a set up, it is essential that the enclosures have good acoustics, that is, acceptable reverberation time without any specific acoustic defects such as flutter, echoes or dead areas.

6.2 Quality of Reproduction

6.2.1 The sound reproduction resulting from indoor public address systems may be classified as follows with reference to the quality of reproduction:

a) 'A' *category* — desirable when high quality reproduction is aimed at (for example, theatre, halls and large auditoria having good acoustical properties).

b) 'B' *category* — Adequate for lecture and assembly halls and similar applications.

6.2.2 'A' category system should be governed by the following requirement:

a) *Frequency response* — The frequency response of the system (excluding loudspeakers) shall be within ±3 dB from 100 to 10 000 Hz.

b) *Harmonic distortion* — Total harmonic distortion of the system (excluding loudspeakers) shall not exceed 5.0 percent at rated output of the amplifier.

c) *Signal-to-noise ratio* — The signal-to-noise ratio under operating conditions of the amplifier system as a whole with flat operation of the tone control shall not be worse than 50 dB.

6.2.3 'B' Category systems should have a useful frequency range from 100 to 7 500 Hz within ±3 dB (excluding loudspeakers). In noisy and reverberant locations this can be further limited to improve speech intelligibility.

6.2.4 The essential characteristics required of the entire system and of the individual sections for high quality and general purpose types of installations are given in **7** and Annex A.

6.3 Electrical Power Requirement

6.3.1 A nomogram connecting the various design quantities; such as volume to be covered, required sound pressure level, reverberation time of the hall and the loudspeaker efficiency to determine the required electrical power output of the amplifying system, and the method of use of the nomogram are given in Annex B. However, care should be exercised in using the nomogram as this is applicable only to hall having good acoustics and negligible feedback effect from the loudspeaker-microphone installation.

7 CHOICE OF EQUIPMENT

7.1 General

Normally the installations comprise the following principal items of equipment:

a) *Source of Input Signals* — One or more microphones, cassette player or any other sound recording and reproducing equipment;

b) *Amplifying Equipment System* — One or more amplifiers; and

c) *Loudspeakers.*

7.2 Source of Input Signals

The input signals for operation of the installation are generally derived from one or other of the devices mentioned in **7.1**(a).

7.2.1 *Microphones*

a) *Moving Coil Microphone* — These are commonly used and have robust construction. Normally low impedance microphones are used as these permit the use of long microphone lines. These should have uni-directional characteristics which helps in reducing acoustic feedback/howling specially in indoor sound system.

b) *Condenser Microphone* — Due to smaller size condenser microphones are commonly used for lavallier application either as Tie Pin Type or as Neck Type. These microphones require 1.5 V battery to power electrect condenser cartridge. These microphones have higher sensitivity compared to moving coil microphones.

7.2.2 *Recording and Reproducing Equipment*

Whenever recording of programmes or playing pre-recorded music on P.A. System is required, rugged high quality cassette recorder/player should be provided.

7.3 Amplifying System/Equipment

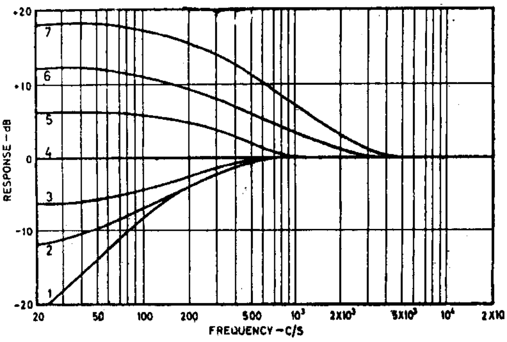
The rated output power of the amplifying equipment should be sufficient to work the loudspeaker load connected to the output line. The amplifier which may have a sensitivity sufficient to operate only from the highest input voltage likely to be met with, has to be supplemented with pre-amplifier for use with sources of lower voltage. Either integrated amplifier having facility for accepting input signal from various sources mentioned in **7.2** or a separate mixer and booster combination can be used.

7.3.1 The output transformers (*see* **7.5.2**) of the amplifiers should have impedance tappings of 4, 8 and 16 ohms to enable operation with loudspeakers of these standard impedances.

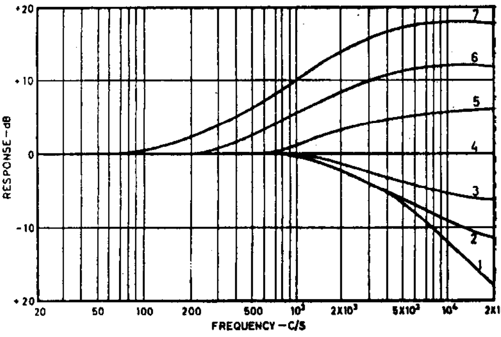
7.3.1.1 When specified, the transformer should be provided with 70 to 100 volts constant voltage tappings (*see also* **7.5.3**).

7.3.2 High power amplifiers should be capable of withstanding short term over load, etc. Also incorporate safeguards against excessive voltage or current rise in case of open circuit conditions or short circuit conditions respectively, in the output circuit.

7.3.3 The frequency response of the amplifiers used for high quality reproduction should be within ± 3 dB from 75 to 10 000 Hz. For general purpose, the response should be within ±3 dB from 100 to 7 500 Hz.



1A BASS CONTROL



1B TREBLE CONTROL

FIG. 1 TONE CONTROL RESPONSE CURVES FOR HIGH QUALITY REPRODUCTION

7.3.4 The amplifying system may be provided with tone controls. For high quality reproduction, there should be provision for both bass and treble controls. The variation of the response curves with the tone control may be as shown in Fig. 1.

For general purpose reproduction, only a bass control need be provided. The variation in response with such a bass control may be as shown in Fig. 2.

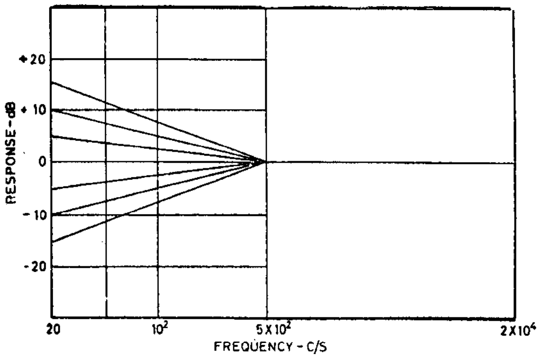


FIG. 2 TONE CONTROL FOR GENERAL PURPOSE REPRODUCTION

7.4 Loudspeakers

The choice of loudspeakers and their correct location should receive careful attention as it is of major importance for satisfactory sound distribution in the enclosure.

7.4.1 The loudspeakers used should have adequate power handling capacity and should normally be of high efficiency type.

7.4.2 Loudspeakers used for high quality reproduction should have effective frequency range of 100 to 10 000 Hz (The response of the speaker system within the environment after installation should be considered as the effective frequency response.)

7.4.3 For general purpose reproduction, the loudspeaker should have useful response from 100 to 7500 Hz. Cabinet type speaker system enclosing one or more cone loudspeakers should be adequate for such purposes.

7.5 Loudspeaker-Line-Matching Transformers

7.5.1 In certain indoor installations, a large number of loudspeakers of different type connected to the output of the amplifying system through loudspeaker-line-matching transformers may be required.

7.5.2 These transformers should have at least the minimum frequency characteristics required of the public address system. The power handling capacity of the transformer used with a loudspeaker should not be less than the power to be absorbed by the speaker. These should have several taps on primary and/or secondary to give multiple turns ratio (*see* **7.3.1**).

7.5.3 These transformers enable the loudspeakers, through the selection of proper turns ratio, to take an input of the determined value of audio from the amplifier, care being taken at the same time not to overload the loudspeaker. Where the constant voltage output line from the amplifier (*see* **7.3.1.1**) is used, the total wattage of loudspeaker load should not exceed the rated power of the amplifier.

8 INSTALLATION PRACTICE

8.1 Assembly and Mounting of Amplifying Equipment

8.1.1 *General*

All equipment should be robustly made and designed for continuous operation. Equipment should securely be installed in such a manner as to have convenient access to all sides of it. Access by unauthorized persons should be guarded against. Precautions should be taken to keep away dust from the equipment, especially if earth moving machines, concrete mixers, etc, are working in immediate vicinity of the accommodation provided.

8.1.2 *Controls*

All preset controls should be mounted behind cover plates and designed for adjustment only by use of a tool, such as a screw driver. The use of manual controls should be restricted to as few as necessary. All controls should be mechanically and electrically noiseless.

8.1.3 *Mounting*

8.1.3.1 For temporary installation or when the number of items of equipment is not large, they may be placed on a table and wired. The positioning of the equipment should be such that the lengths of the inter connecting cables are kept minimum for convenience.

8.1.3.2 *Rack mounting*

For permanent installation or in case the number of items is large, it is desirable to mount them in racks of suitable dimensions. The racks may be of metal or wood and having compartments of uniform width assembled together. Each compartment shall contain one item of equipment. The height of the rack will depend on the number of items to be mounted and accommodation available, ensuring that all manual controls are within easy reach. Switches should be provided for isolating any faulty section of the equipment, thereby facilitating operation and avoiding danger to the operating personnel. The arrangements made should enable the remaining part of the equipment to be available for use. The patch cords, if used, should be tested and neatly arranged to avoid obstruction and should be easily identifiable. Necessary safety measures should be adopted to avoid accidental contacts with high voltage points in the rack.

8.2 Microphone Installation

8.2.1 Microphones should be, as far as possible, behind the loudspeakers in order to minimize acoustic feedback. The microphone stands may be on the floor, table or desk type, capable of adjustment so that the height and direction of the microphone can be adjusted to suit the speaker. The microphone plugs and sockets should preferably be multi-contact type and freely interchangeable.

The microphone sockets may be permanently fixed on the foot-light troughs as shown in Fig. 3 or suspended from ceiling. When suspended types of microphones are used, these should be hung and concealed from the audience.

8.2.2 The correct distance between the microphone and source should be predetermined and arranged to be constant as far as possible. It is important to see that if the level of reverberant sound (undesired) or surrounding noise near the microphone is high, the distance between the microphone and the source of sound (desired) should be reduced. The sound source should be directed towards the microphone as otherwise the high notes which are highly directional, would not be satisfactorily picked up by the microphone and thereby the clarity of the speech sound reproduced by the public address system will be poor.

8.2.3 Microphone should be low impedance type which permits the use of long microphone cables without any loss of high frequencies.

8.2.4 When more than one microphone is employed, the output from several microphones should be mixed in a mixer and the common output fed to the amplifiers. Where the amplifier itself is capable of mixing the individual microphone inputs, separate mixer is not required.

8.3 Loudspeaker Installation

8.3.1 *General*

For high quality reproduction, directional type of loudspeakers should be used. Vertical directivity pattern of the system should be such as to feed the audience at uniform level, avoid harmful reverberant sound or echo, and avoid feedback of energy to the microphones. In the horizontal plane, the directivity should be uniform across the width of the hall.

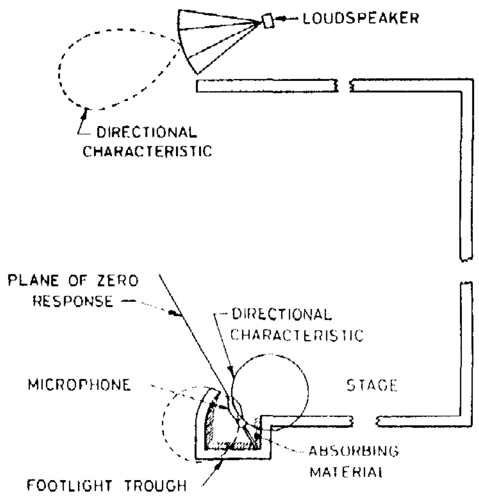


FIG. 3 TYPICAL MICROPHONE LOCATION, INSTALLATION AND DIRECTIVITY PATTERN

8.3.2 *Column Loudspeakers*

Column loudspeakers are ideal for obtaining the vertical directivity pattern. The height of the column and the number of speakers in it determine the directivity. A wide range of high quality reproduction may be obtained by employing multi-unit type, wherein the whole frequency range will be covered by two or three groups of speakers arranged in separate columns but mounted close to each other and connected through a properly designed dividing network. When multi-unit columns are used, they should be so connected that their diaphragms operate in phase.

8.3.3 The directivity pattern of such speakers should be such as to provide sufficient intelligibility at all points of the seated area and avoid feedback to the microphone, dead spots and echo.

8.3.4 The column speakers should be so located that the sound reaching the audience comes from a logical direction. For high quality reproduction, a single column should be used and mounted above the proscenium or behind the screen in case of cinema halls.

8.3.5 In assembly halls and lecture halls where the sound distribution system does not cover all of the audience, small separate units may be installed to feed the audience in remote locations. Small bowl type speakers on ceiling and balcony soffits or inclined cabinet type speakers on side walls in addition to cabinet speakers on either side of the proscenium may be used if necessary.

8.3.6 When loudspeakers in addition to those on the proscenium are used, care should be taken to see that the direct sound from stage is not delayed behind that from the loudspeaker so much as to appear as a distinct and separate sound (or echo). In the event of such trouble, sound from the loudspeaker at remote location should be delayed correspondingly by means of magnetic tape or digital delay system.

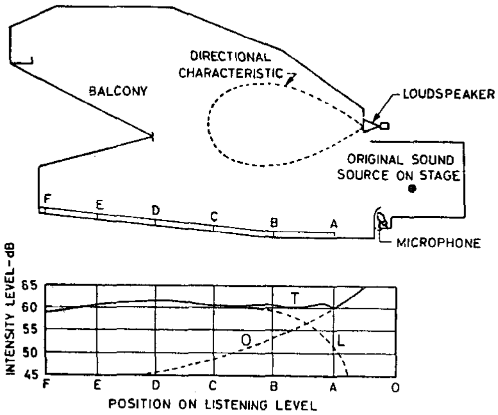
8.3.7 The loudspeaker unit used should be oriented in vertical plane and its main axis of radiation should be so directed that the radiation lobe of the loudspeaker feeds the whole area uniformly. The direct sound from the stage, reproduced sound from the loudspeaker and the reverberant sound should all combine to establish a more or less uniform sound field throughout the audience. An illustration of this is shown in Fig. 4.

8.3.8 Unrestricted areas like the main seating area, having normal sound absorption, should be served by high efficiency loudspeakers. The speakers near or in the proscenium should be fairly large and of the high efficiency type.

8.3.9 Restricted areas with or without absorptive treatment may contain small units of medium efficiency. The loudspeakers at the rear of the main floor should be mounted in small cabinets or be of bowl type.

8.3.10 When a single loudspeaker unit is connected to the amplifying system, its impedance should be matched to the source imepdance so as to consume the rated power. The impedance transformation from the voice coil impedance to the source impedance shall be effected through impedance transformers, where the

$$\text{Transformer ratio} = \sqrt{\frac{\text{Line impedance}}{\text{Speech coil impedance}}}$$


DIRECTIONAL CHARACTERISTIC
BALCONY
LOUDSPEAKER
ORIGINAL SOUND SOURCE ON STAGE
MICROPHONE
F
E
D
C
B
A
INTENSITY LEVEL-dB
65
60
55
50
45
T
O
L
F
E
D
C
B
A
O
POSITION ON LISTENING LEVEL

O — Due to Original Sound *L* — Due to Loudspeaker
T — Resultant Intensity

FIG. 4 TYPICAL SOUND REINFORCING ARRANGEMENT IN A THEATRE

8.3.11 In case of matched systems, when a number of loudspeakers are connected to the same output circuit, matching transformers should be used with each speaker so that it consumes rated power only. In case of constant voltage systems, the total load connected should be such that the rated power of the amplifier is not exceeded.

8.3.12 Volume controls are to be fixed to individual loudspeakers or groups of loudspeaker, only when there is a positive need for them. If used, the gradation of the volume control should be in convenient steps; in most cases only two positions, high and low, may be necessary . The most satisfactory type of volume control is the tapped transformer. However, where resistive controls have to be used, the total resistance of each control should be of the order of four times the impedance of the loudspeaker at 400 Hz.

8.4 Mixer Consoles

8.4.1 When large number of microphone inputs are required, these can not be handled by mixing stage provided in the amplifier. For such applications audio mixing consoles should be provided. Normally audio mixing consoles are for 8, 12 and 18 inputs.

8.4.2 Audio mixing consoles should provide following minimum facilities:

a) 3 Band equalizer for 'Bass', 'Mid' and 'Treble' cut and booster controls for each channel.
b) Sensitivity control for each channel to adjust the input, thus preventing overloading of each channel.
c) Overload indicator LED for each channel.
d) Facility for programme.
e) Facility for stage monitoring (fold back).

8.4.3 For general purpose reproduction low level Mixing may be satisfactory, provided the hum level does not exceed the specified limit.

8.5 Wiring and Cabling

8.5.1 *Microphone and Other Input Source Cables*

These carry low level signal currents and are therefore susceptible to electrical interference. It is preferable to use twin core screened (copper braiding) microphone cable. The copper braiding should be sheathed with an insulating covering. The microphone cables should be isolated from power, loudspeaker and telephone cables.

8.5.1.1 Joints in the cables should be avoided as far as possible. The plugs and sockets used for microphone cables should have strong self cleaning contacts so as to eliminate noise and they should be non-reversible and have a sufficient number of pins to connect not only the main conductors but also the cable shield.

8.5.1.2 Microphone cables should be laid without sharp bends as far as possible. Inside the building they may be laid on the floor along the walls or under the carpet to avoid damage due to heavy object falling on them and cutting them. When laid in the open, they should be either buried in the ground to a depth of not less than 20 cm or laid through an iron pipe buried in the ground to a depth of 15 cm if heavy pressure is expected due to movement of personnel over the surface. They may also be laid overhead at a height not less than 3.5m from the ground clipped securely to a bearer wire which may be galvanized iron of diameter 1.60 to 2.00 mm, the length depending on the span of suspension. Protection by conduit or capping should be provided wherever there is a risk of damage or interference with the wiring. Any wiring, that is, to be run below about 1.8 m in height along corridors or outside walls or on the floor should be protected likewise. The conduit should permit easy drawing in and out of the cables. The input and output cables of the amplifying equipment should not be run in the same conduit in which mains power supply cables are drawn.

8.5.2 *Wiring of the Equipment*

A schematic diagram of the equipment, switching arrangements and incoming and outgoing lines should be drawn before the equipment is assembled and wired. The main and stand by equipment (if any) is wired in accordance with the scheme. Patch cords, if used, for connecting the equipment should be carefully checked for faults before use.

8.6 Power Supplies

8.6.1 *Mains Supply*

8.6.1.1 The equipment should normally be operated from 240 volts single phase 50 Hz AC mains supply. If, however, the supply is different, for example, 110 volts AC, a transformer of the required capacity and rating may be used.

8.6.1.2 Three-phase mains-power supply may be used for deriving power to run the system, each phase being capable of delivering the total output necessary to operate the amplifying and the associated equipment. The equipment should be connected to one phase, the second phase being set apart for the load taken by the soldering iron, test gear, inspection lamps, etc, and leaving the third as spare for use in an emergency.

8.6.1.3 A voltage regulating device will have to be provided if the regulation of the power supply is poorer than +5 percent.

8.6.1.4 The supply mains should be terminated in an iron clad switch with fuses of adequate capacity to meet the estimated load and provided with indicator lamps for each phase. Auxiliary switch board with 3 pin socket outlets and switch controls should be provided for connecting the soldering iron, test gear, inspection lamps, etc.

8.6.1.5 If non standard voltage or frequency is required to operate the equipment, an invertor/convertor set of suitable rating will have to be used to obtain the required voltage and frequency.

8.6.1.6 When only DC supply is available an invertor/convertor of required capacity should be provided to convert the DC supply to AC.

8.6.2 *Absence of Mains Supply*

If no mains supply is available, petrol or diesel engine driven generating sets of the required capacity giving 240 volts, single phase, 50 Hz AC power supply should be used. Such a generating set should be located at sufficient distance from the rostrum preferably a large building shielding it, so that its noise at the rostrum is not higher than what is present in the vicinity.

8.6.3 *Battery Supply*

In case of low power installations or when no mains supply is available, the amplifying system should be capable of operation directly from a strong battery.

8.6.4 All amplifiers should preferably be capable of operating on 12 V/24 V DC car battery besides on 240 V, 50 Hz AC supply.

9 EARTHING AND OTHER SAFETY PRECAUTIONS

9.1 General

The layout and wiring of cables for loudspeakers shall, as far as possible, be so done as to ensure safety and avoidance of the installation. The *Indian Electricity Rules*, 1956 and the Indian Standard Code of Practice for Electrical Wiring and Fittings in Buildings, should also be followed as far as they are applicable for wiring loudspeaker installations.

9.2 Earthing

9.2.1 Proper earthing of the entire installation (with appropriate earthing of the individual equipment also) is absolutely essential to avoid danger from any possible shock to the users of the equipment, the operating personnel or the audience

9.2.2 Earthing connections to the nearby water mains are of usually lower resistance than any form of buried earth-electrode system. An equipment or installation may be satisfactorily earthed by means of connection to the nearest water supply mains by a suitable water main. The earthing may also be done by connecting to other efficiently earthed object by a good soldered joint or an earth clip.

9.2.3 The use of two or more separate earthing connections at different points on the system is inadvisable due to risk of trouble from circulating currents. While one end of the earthing wire or cable is connected to the water supply main or other earthed object, the other end shall be brought to a point on the installation to which shall be connected all the earthing leads from the various sections of installation as well as the binding wires from all incoming lead-covered and screened cables except the microphone screening leads. The screening leads of the microphone should have a separate insulated lead running direct to the earth connection. It shall not be connected to the electrical earthing of the installation which gives rise to hum.

9.2.4 A fairly heavy cable (such as 7/0.75mm VIR in conduit) or bare copper wire (of 4.0 mm dia) is normally satisfactory as the earthing connection lead. If bare copper wire is used, care should be taken to run it insulated from other metallic objects all along its length.

9.3 Safety Requirements of Amplifiers

The amplifier or amplifiers separating from mains supply should conform to the requirements specified in IS 616.

9.4 Fire and Explosion Risk

The installation of the system in a situation where there may be a possibility of an explosion, or in a flammable atmosphere, should as far as possible be avoided. However, if it becomes necessary to have the installation in such a situation, it should not be vulnerable to fire explosion risks.

10 STAND-BY EQUIPMENT

10.1 The installations may be roughly classified under three categories as follows:

a) The breakdwon of the equipment should be restored instantaneously setting aside the faulty equipment without waiting for servicing the faulty equipment;

b) The breakdown should be restored quickly, say, within about 10 minutes, by servicing the faulty equipment; and

c) The breakdown of the equipment will not vitally affect the situation.

10.2 For the installation of category (a) mentioned above, at least hundred percent stand-by equipment will have to be provided so that all the working channels could be replaced on failure by a stand-by set of channels. The wiring of the input and output of the amplifiers is done in such a manner that the changeover from the main amplifier could be done by operating switches (for example, *see* Fig.1). After the changeover, the defective main amplifier could be serviced and kept ready for use again, if the meetings were to continue for sufficiently long time. Independent stand-by power supply unit, for example, petrol or diesel engine driven AC generator of the required capacity giving 240 volts AC single phase, should be provided. Wherever conveniently possible, a 12/24 volts storage battery operated amplifier complete with fully charged battery(ies) should be kept ready for switchover.

10.3 For installations of categories (b) and (c), sufficient care should be taken for easy accessibility of the lines, switches and equipment that are installed for quick location and servicing of the fault in the system.

11 INSPECTION, TESTING AND MONITORING

11.1 Inspection and Testing

The complete installation should be inspected and tested by the engineer to ensure that the work has been carried out in a satisfactory manner, the materials and components used conform to the recommendation of this code and that the plan and operating instructions called for in the respective clauses have been furnished.

11.2 Monitoring

For effectively controlling the working of the Public Address System, some form of monitoring equipment, such as an output level indicator or monitoring loudspeakers should be provided with their own volume controls and with provision for being switched over to other parts of the installation.

ANNEX A

(*Clause* 6.2.4)

REQUIREMENTS OF EQUIPMENT USED FOR INDOOR SOUND DISTRIBUTION SYSTEM

Equipment	Characteristic	Requirements for	
		General Purposes	High Quality (Excluding Stereophonic Purposes)
(1)	(2)	(3)	(4)
	Frequency response (excluding loudspeaker)	±3 dB from 100 to 7 500 Hz	±3 dB from 100 to 10 000 Hz
Entire installation (overall)	Signal-to-noise ratio at comfortable listening position and at the flat portion of tone control response	Shall not be worse than +40 dB	Shall not be worse than +50 dB
	Sensitivity	Capable of direct operation from input voltage ranging 0.5 mV to 1.5 V	
Amplifying system	Frequency response (excluding loudspeakers)	±3 dB from 100 to 7 500 Hz	±3 dB from 100 to 10 000 Hz
	Provision of tone control	Bass control to provide response curves as shown in Fig. 2	Bass and treble controls to provide response curves as shown in Fig. 1
Microphones	Frequency response	±3 dB from 100 to 7 500 Hz	±3 dB from 100 to 10 000 Hz
Loudspeakers	Effective frequency range (10 dB below average response)	100 to 7 500 Hz	100 to 10 000 Hz

ANNEX B

(*Clause* 6.3.1)

NOMOGRAM FOR DETERMINATION OF AUDIO POWER IN INDOOR SOUND DISTRIBUTION SYSTEM

B-1 METHOD OF USE OF NOMOGRAM

B-1.0 General

This nomogram (*see* Fig. 5) has been arrived at conditions met under acoustically treated halls where the microphone feedback is not appreciable.

B-1.1 Method

B-1.1.1 Suppose it is required to determine the power of sound reinforcing audio amplifier installed in a hall having a volume of 15 000 cubic metres and reverberation time of 1.4 seconds, efficiency of installed loudspeakers being 10 percent.

B-1.1.2 Let the desired sound pressure level be 90 dB in the hall. Thus starting at the 90 dB point on the left scale of the nomogram, a straight line is drawn through the 15 000 cubic metre volume point to the datum line. From the point reached on the datum line a straight line is drawn through the 1.4 second reverberation time point reaching the vertical line representing the acoustical power. This point (3.0 Watts) is the acoustical power required for establishing a sound pressure level of 90 dB in the hall in question.

B-1.1.3 From the acoustic power point thus obtained, another straight line is drawn through the 10 percent point representing the loudspeaker efficiency, to the vertical line on extreme right. This point (3.0 Watts) gives the electrical power input to the loudspeaker or the audio power output from the sound reinforcing amplifier. The amplifier should, in addition, have a reserve gain of at least 10 dB above the maximum sound pressure level desired to be established. This audio electrical output, to build up a sound pressure level of 100 dB, will be 10 times the above calculated power, that is, 30 Watts.

B-1.1.4 The amplifier to be installed should, therefore, be capable of delivering 30 Watts of undistorted output to the loudspeaker in the hall.

B-1.2 Determination of Reverberation Time

B-1.2.1 If the reverberation time of the enclosure is known, the power required may be determined as described in **B-1.1**. When the reverberation time is neither known nor can it be measured, the optimum reverberation time as obtained from Fig. 6 may be used in the nomogram.

B-1.2.1.1 The error involved due to variation of the reverberation time from the optimum is not likely to exceed 2 dB.

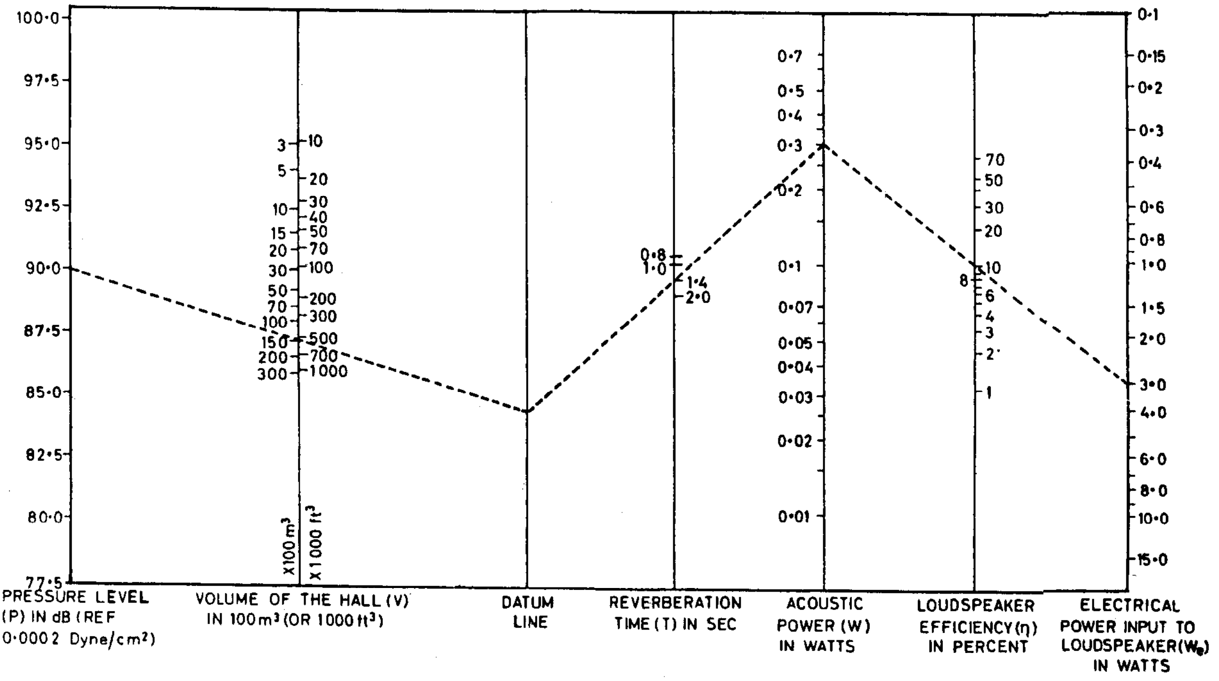


FIG. 5 NOMOGRAM FOR DETERMINATION OF AUDIO POWER

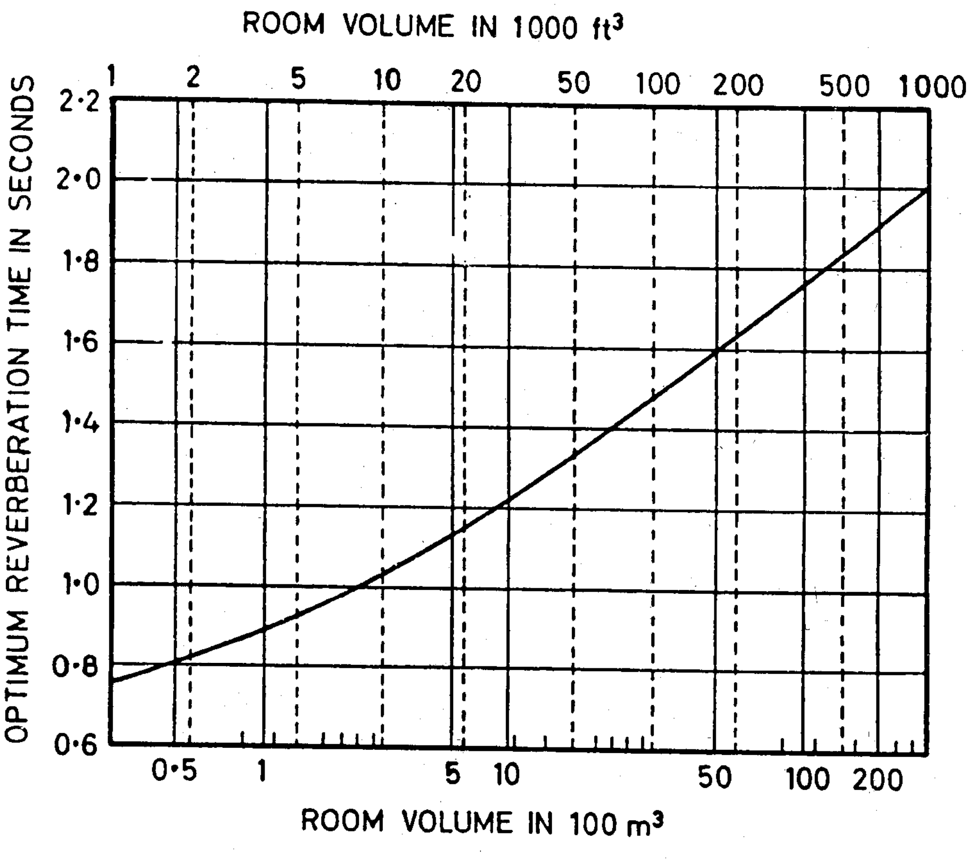


FIG. 6 OPTIMUM REVERBERATION TIME AS A FUNCTION OF ROOM VOLUME (512 c/s)

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